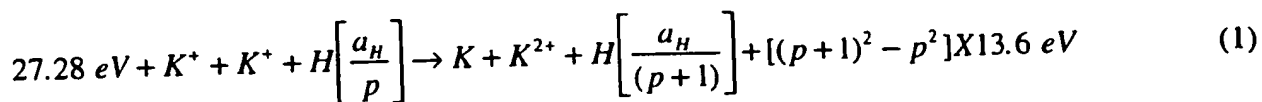# HYDROCATALYSIS POWER CORPORATION

Comments to Confidential Draft Report from Westinghouse STC, "Evaluation of Heat Production From Light Water Electrolysis Cells of HydroCatalysis Power Corporation", February 25, 1994
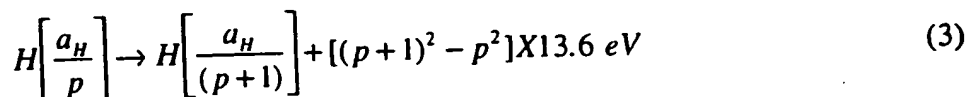
Light Water Calorimetry Experiments

Westinghouse scientists report that excess heat was observed during the electrolysis of aqueous potassium carbonate (K^+/K^+ electrocatalytic couple); whereas, no excess heat was observed during the electrolysis of aqueous sodium carbonate.

The data of the temperature of the cell minus the ambient temperature shows that when potassium carbonate replaced sodium carbonate in the same cell with the same input electrolysis power, **the potassium experiment was twice as hot as the sodium carbonate experiment for the duration of the experiment, one month.** The present experimental results are consistent with the release of heat energy from hydrogen atoms where pairs of potassium ions (K^+/K^+ electrocatalytic couple) induce the electrons of hydrogen atoms to relax to quantized energy levels below that of the "ground state" by providing a net enthalpy equal to an integer multiple of 27.2 eV which stimulate these transitions. The balanced reaction is given by Eqs. (1-3) below. Excess heat was observed only when Na_2CO_3 was replaced by K_2CO_3. For two sodium ions, no comparable reaction with a net enthalpy equal to an integer multiple of 27.2 eV is possible. (see Eq.(4) below). The excess energy could not be explained by recombination or known chemistry.

Theoretical Explanation An efficient catalytic system that hinges on the coupling of three resonator cavities involves potassium. For example, the second ionization energy of potassium is 31.63 eV. This energy hole is obviously too high for resonant absorption. However, K(I) releases 4.34 eV when it is reduced to K. The combination of K(I) to K(II) and K(I) to K, then, has a net energy change of 27.28 eV.

$$27.28 \ eV + K^+ + K^+ + H\left[\frac{a_H}{p}\right] \rightarrow K + K^{2+} + H\left[\frac{a_H}{(p+1)}\right] + [(p+1)^2 - p^2]X13.6 \ eV \tag{1}$$

$$K + K^{2+} \rightarrow K^+ + K^+ + 27.28 \ eV \tag{2}$$

And, the overall reaction is

$$H\left[\frac{a_H}{p}\right] \rightarrow H\left[\frac{a_H}{(p+1)}\right] + [(p+1)^2 - p^2]X13.6 \ eV \tag{3}$$

For two sodium ions, no comparable reaction with a net enthalpy equal to an integer multiple of 27.2 eV is possible. For example, 42.15 eV of energy is absorbed by the reverse of the reaction given in Eq. (2.14), where Na^+ replaces K^+ :

$$Na^+ + Na^+ + 42.15 \ eV \rightarrow Na + Na^{2+} \tag{4}$$
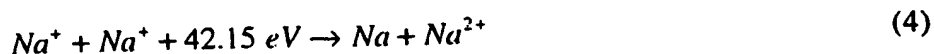
Faraday Efficiency

A Westinghouse research scientist proposes that the excess energy may be due to recombination (burning of the evolving hydrogen and oxygen) or some exotic chemical reaction of the counterion of the electrolyte which consumes some of the current that otherwise would electrolyze water.

The general form of the energy balance equation for the cell in steady state is:

$$0 = P_{in} + P_{xs} - P_{loss} \tag{5}$$

where P_{in} is the input power; P_{xs} is the excess power generated (the source of this power is given by Eqs. (1)-(3) above); and P_{loss} is the thermal power loss from the cell. In these experiments, the applied voltage, V_{appl}, and the current, I, were constant. Thus, the input power is given by

$$P_{in} = V_{appl} I \tag{6}$$

When an aqueous solution is electrolyzed to liberate hydrogen and oxygen gases, the input power can be partitioned into two terms:

$$P_{in} = P_{ohm} + P_{gas} \tag{7}$$

where P_{ohm} is the ohmic power that heats the cell and P_{gas} is the power needed to produce the H_2 and O_2 gases.

$$H_2O\ (l) \rightarrow H_2\ (g) + \frac{1}{2}O_2\ (g) \tag{8}$$

An expression for $P_{gas}(= V_{gas}\ I)$ is readily obtained from the known enthalpy of formation of water ($\Delta H_f = -286$ kJ/mole):

$$V_{gas} = -\frac{\Delta H_f}{\alpha F} = -\frac{-286\ X\ 10^3\ J\ /\ mole}{2\ X\ 96484\ C\ /\ mole} = 1.48 volts \tag{9}$$

where α is the number of moles of electrons involved in the reaction and F is the Faraday constant. The net Faraday efficiency of gas evolution is assumed to be unity. Thus, the ohmic power is given by

$$P_{ohm} = (V_{appl} - 1.48)\ I \tag{10}$$

The **experimentally observed** rise in temperature of the potassium experiment was twice that of the sodium experiment. The temperature rise cannot be attributed to a hypothesis that the net faraday efficiency of gas evolution is not unity, because it was **experimentally measured to be unity** by weighing the experiment to determine that the expected rate of water consumption was observed, and the output power exceeded the **total** input power. This further overcomes the hypothesis of Isenberg that an extremely unusual chemical reaction of the carbonate ion was responsible for consuming the current. Furthermore, the hypothesis of Isenberg is highly improbable, for the following reasons:

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- The chemical reactions proposed by Isenberg would be expected to occur to the same extent in the sodium control experiment, which showed no excess, heat because they both potassium and sodium cells contained equivalent amounts of carbonate and were operated under identical conditions.

- Production of percarbonate from carbonate **consumes** energy, as opposed to **producing** energy.

- The carbonate concentrations of all of the experiments was analyzed following their completion, and the final carbonate concentration in all cases was about the same as the starting concentration. The slight decrease in carbonate over the length of the experiments is attributed to the very slow conversion of carbonate to carbon dioxide and hydroxide at the anode at elevated temperature as given by Itskovich ["Electrolysis of aqueous potassium carbonate solutions in a model electrolytic cell", Itskovich, A. R.; Merenkov, P. T., (Inst. Khim., Tashkent, USSR). *Dokl. Akad. Nauk Uzb. SSR* **1968**, 25(7)].

- Electrochemical reactions which consume the electrolyte can be ruled out because any proposed electrochemical reactant would be completely consumed over the duration of these experiments.

In the case of the last point above, the current of each experiment was 3 A, and each experiment contained 1.5 liters of 0.57 molar electrolyte. Thus, the total number of moles of electrolyte was

$$0.57 \text{ moles/liter} \times 1.5 \text{ liters} = 0.85 \text{ moles} \tag{11}$$

According to Faraday's Law, a current of 3 amperes consumes one mole equivalent in 8.9 hours.

$$\frac{96484 \text{ coulombs / mole equivalent}}{3 \text{ coulombs / second}} = 32,161 \text{ seconds} = 8.9 \text{ hours} \tag{12}$$

The duration of the experiment was **one month**, and the excess energy was **constant** over the duration of the experiment.

Summary

The data clearly indicate that excess heat was generated in each electrolytic cell experiment using potassium carbonate. The experiments were permitted to operate for weeks, and the excess heat remained relatively constant. What is the source of this excess enthalpy? Electrochemical reactions which consume the electrolyte can be ruled out, because any proposed electrochemical reactant would be completely consumed over the duration of these experiments. The Faraday efficiency was measured to be 100% for both electrolytes. The results are consistent with the release of heat energy from hydrogen atoms where the K^+/K^+ electrocatalytic couple induces the electrons of hydrogen atoms to relax to a quantized potential energy level below that of the "ground" state, by providing a redox energy-energy hole (27.28 eV) resonant with this transition. The balanced reaction is given by Eqs. (1-3).

No excess heat was observed until K_2CO_3 replaced by Na_2CO_3. For two sodium ions, no comparable reaction with a net enthalpy equal to an integer multiple of 27.2 eV is possible as given by Eq. (4).

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